

FORM PTO-1390
(REV 11-98)

U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

ATTORNEY'S DOCKET NUMBER

**TRANSMITTAL LETTER TO THE UNITED STATES
DESIGNATED/ELECTED OFFICE (DO/EO/US)
CONCERNING A FILING UNDER 35 U.S.C. 371**

9319S-000126

U.S. APPLICATION NO. (if known see 37 CFR 1.5)

09/530122

INTERNATIONAL APPLICATION NO.

PCT/JP99/04364

INTERNATIONAL FILING DATE

11 August 1999 (11.08.99)

PRIORITY DATE CLAIMED

31 August 1998 (31.08.98)

TITLE OF INVENTION

LIQUID CRYSTAL PANEL AND METHOD OF FABRICATING THE SAME

APPLICANT(S) FOR DO/EO/US

Hiroki NAKAHARA, Hideki UEHARA, Takashi MIYAZAKI and Takeshi HAGIWARA

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND or SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☒ This express request to begin national examination procedures (35 U.S.C. 371(f)) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(l).
4. ☐ A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.
5. ☒ A copy of the International Application as filed (35 U.S.C. 371(c)(2))
 - a. ☐ is transmitted herewith (required only if not transmitted by the International Bureau).
 - b. ☒ has been transmitted by the International Bureau.
 - c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ☒ A translation of the International Application into English (35 U.S.C. 371(c)(2)).
7. ☒ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))
 - a. ☐ are transmitted herewith (required only if not transmitted by the International Bureau).
 - b. ☐ have been transmitted by the International Bureau.
 - c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
 - d. ☒ have not been made and will not be made.
8. ☐ A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. ☒ An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).
10. ☐ A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11. to 16. below concern document(s) or information included:

11. ☒ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
12. ☒ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. ☒ A FIRST preliminary amendment.
☐ A SECOND or SUBSEQUENT preliminary amendment.
14. ☐ A substitute specification.
15. ☐ A change of power of attorney and/or address letter.
16. ☒ Other items or information: PTO-1449 and copies of the references cited therein; 12 sheets of drawings showing FIGS. 1-12; International Search Report in Japanese; English translation of International Search Report; Request for Approval of Drawing Changes with 2 sheets of drawings showing amended FIGS. 11A, 11B and 12.

U.S. APPLICATION NO (if known see 31 CFR 1.5)

INTERNATIONAL APPLICATION NO

ATTORNEY'S DOCKET NUMBER

9319S-000126

09/530122 PCT/JP99/04364

17. ☒ The following fees are submitted:**BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5))**

Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO \$970.00

International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO \$840.00

International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO \$760.00

International preliminary examination fee paid to USPTO (37 CFR 1.482) but all claims did not satisfy provisions of PCT Article 33(1)-(4) \$670.00

International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(1)-(4) \$96.00

ENTER APPROPRIATE BASIC FEE AMOUNT =**CALCULATIONS PTO USE ONLY**

Surcharge of \$130.00 for furnishing the oath or declaration later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492(c)).

CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE
Total claims*	21 -20 =	1	X \$18.00
Independent claims	3 -3 =	0	X \$78.00

MULTIPLE DEPENDENT CLAIM(S) (if applicable) +\$260.00

TOTAL OF ABOVE CALCULATIONS =

Reduction of 1/2 for filing by small entity, if applicable. A Small Entity Statement must also be filed (Note 37 CFR 1.9, 1.27, 1.28).

SUBTOTAL =

Processing fee of \$130.00 for furnishing the English translation later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492(f)).

TOTAL NATIONAL FEE =

Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). \$40.00 per property +

TOTAL FEES ENCLOSED =

Amount to be:	\$
refunded	
charged	\$

- a. ☒ A check in the amount of \$ 898.00 to cover the above fees is enclosed.
- b. ☐ Please charge my Deposit Account No. _____ in the amount of \$ _____ to cover the above fees. A duplicate copy of this sheet is enclosed.
- c. ☒ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 08-0750. A duplicate copy of this sheet is enclosed.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO

G. Gregory Schivley
 Harness, Dickey & Pierce, P.L.C.
 P.O. Box 828
 Bloomfield Hills, MI 48303

SIGNATURE

G. Gregory Schivley

NAME

27,382

REGISTRATION NUMBER

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicants: NAKAHARA, et al.)
) PRELIMINARY
) AMENDMENT
 International)
 Application No.: PCT/JP99/04364)
)
 International)
 Filing Date: August 11, 1999)
)
 For: **LIQUID CRYSTAL PANEL AND METHOD OF)**
FABRICATING THE SAME)

Hon. Commissioner of Patents & Trademarks
 Washington, D.C. 20231

CERTIFICATE OF EXPRESS MAILING

I hereby certify that this correspondence is being deposited with the United States Postal Service as Express Mail in an envelope addressed to: Commissioner of Patents and Trademarks, Washington, D.C. 20231 on

By _____
April 29, 2000
[Signature]

Sir:

Prior to the examination of this application, please amend it as follows:

IN THE SPECIFICATION

Page 2, line 18 to 19 ,please delete "panel 1"and substitute --panel 10--therefore .

Page 3, line 4 , please delete "sealant 4"and substitute --sealant 3--therefore .

Page 3, line 17, please delete "panel 1"and substitute --panel 10-- therefore .

Page 21, line 9, please delete "terminals 12"and substitute --terminals 7D--

therefore .

Page 24, line 6, please delete "substrate 1"and substitute --substrate 1A-- therefore .

IN THE CLAIMS

Please amend the following claims:

3. (AMENDED) A liquid crystal panel according to Claim 1 [one of Claims 1 and 2], wherein the alignment layer is formed up to the region overlapping the region for forming the sealant in the sections corresponding to four sides of the substrate.

4. (AMENDED) A liquid crystal panel according to Claim 1 [any one of Claims 1 to 3], wherein the alignment layer is formed up to the edges of the substrate across the region for forming the sealant in the individual sides of the substrate excluding the side provided with input-output terminals and terminals for conducting between substrates.

5. (AMENDED) A liquid crystal panel according to Claim 1 [any one of Claims 1 to 4], wherein a transparent insulation film for covering the electrodes on the lower layer side of the alignment layer is formed in the region substantially overlapping the region for forming the alignment layer.

6. (AMENDED) A method of fabricating a liquid crystal panel defined in Claim 1 [any one of Claims 1 to 5], wherein the electrodes are formed on the surface of a large substrate for forming a plurality of pairs of substrates in the individual regions for forming the substrates which are divided by cutting the large substrate along cutting projection lines, and then thin films for forming the alignment layers are formed up to the regions for overlapping the regions for forming the sealant in the sections corresponding to at least three sides of the regions for forming the substrates.

9. (AMENDED) A method of fabricating a liquid crystal panel according to Claim 7 [one of Claims 7 and 8], wherein, in the large substrate, the substrate forming-

regions are placed with a cutting projection line therebetween so that the sides provided with input-output terminals and terminals for conducting between substrates are directed in the opposite directions, and when the thin films for forming the alignment layers are formed, the thin films are formed in [strip] stripe^S_A along the cutting projection line.

Please add the following new claims:

10. (NEW) A liquid crystal panel comprising:

a first substrate;

first electrodes formed on said first substrate;

a first alignment layer formed over said first electrodes;

a second substrate;

second electrodes formed on said second substrate;

a second alignment layer formed over said second electrodes;

a sealant coupled between said first and second substrates so as to form a gap therebetween, said sealant engaging said first and second alignment layers on at least three sides of said first and second substrates.

11. (NEW) The liquid crystal panel of Claim 10 wherein said first alignment layer is interposed between said sealant and said first substrate.

12. (NEW) The liquid crystal panel of Claim 10 wherein said second alignment layer is interposed between said sealant and said second substrate.

13. (NEW) The liquid crystal panel of Claim 10 wherein said first alignment layer

extends to a perimeter of said first substrate.

14. (NEW) The liquid crystal panel of Claim 10 wherein said second alignment layer extends to a perimeter of said second substrate.

15. (NEW) The liquid crystal panel of Claim 10 wherein a fourth side of said first and second substrates includes input-output terminals.

16. (NEW) The liquid crystal panel of Claim 10 further comprising:

a first transparent insulation film interposed between said first alignment layer and said first substrate over said first electrodes; and

a second transparent insulation film interposed between said second alignment layer and said second substrate over said second electrodes, said first and second transparent insulation films complimenting a configuration of said first and second alignment layers.

17. (NEW) A method of fabricating a liquid crystal panel comprising:

providing a first substrate;

defining a plurality of smaller substrate forming regions on said first substrate, said plurality of smaller substrate forming regions being divided by a plurality of projected cutting lines;

depositing electrodes on said first substrate within each of said smaller substrate forming regions;

defining a sealant deposit region along each of said smaller substrate forming regions; and

depositing a thin film for forming an alignment layer on said first substrate, said thin film engaging said sealant deposit region on at least three sides of each of said smaller substrate forming regions.

18. (NEW) The method of Claim 17 wherein said thin film is deposited so as to overlap said sealant deposit region along each of said smaller substrate forming regions.

19. (NEW) The method of Claim 17 wherein said thin film is deposited so as to overlap said plurality of projected cutting lines.

20. (NEW) The method of Claim 17 further comprising depositing a sealant on said sealant deposit region of each of said smaller substrate forming regions.

21. (NEW) The method of Claim 20 further comprising:

providing a second substrate;

defining a plurality of second smaller substrate forming regions on said second substrate, said plurality of second smaller substrate forming regions being divided by a plurality of second projected cutting lines;

depositing second electrodes on said second substrate within each of said second smaller substrate forming regions;

defining a second sealant deposit region along each of said second smaller substrate forming regions;

depositing a second thin film for forming a second alignment layer on said second substrate, said second thin film engaging said second sealant deposit region on at least

three sides of each of said second smaller substrate forming regions;

bonding said second substrate to said first substrate by securing said sealant to said second sealant deposit region along each of said second smaller substrate regions on said second substrate; and

cutting said first and second substrates along said projected cutting lines and said second projected cutting lines.

REMARKS

The purpose of this Preliminary Amendment is to clarify the translation of the application and to add additional claims to provide Applicant with a scope of protection commensurate with its contribution to the art.

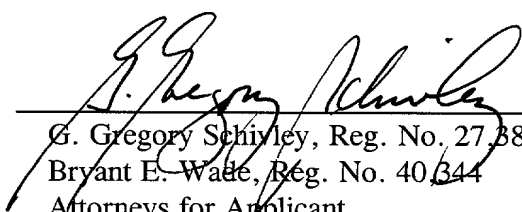
Favorable consideration of this application is respectfully requested.

Respectfully submitted,

Date: April 20, 2000

Harness, Dickey & Pierce, P.L.C.
P.O. Box 828
Bloomfield Hills, MI 48303
(248) 641-1600

By: _____


G. Gregory Schivley, Reg. No. 27,382
Bryant E. Wade, Reg. No. 40,344
Attorneys for Applicant

GGs/BEW/msm

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicants: NAKAHARA, et al.)
)
)
International)
Application No.: PCT/JP99/04364) **REQUEST FOR APPROVAL**
) **OF DRAWING CHANGES**
International)
Filing Date: August 11, 1999)
)
For: **LIQUID CRYSTAL PANEL AND METHOD OF**
FABRICATING THE SAME)

Hon. Commissioner of Patents and Trademarks
Washington, D.C. 20231

CERTIFICATE OF EXPRESS MAILING

I hereby certify that this correspondence is being deposited with the United States Postal Service as Express Mail in an envelope addressed to: Commissioner of Patents and Trademarks, Washington, D.C. 20231 on

By *G. Gregory Schiyley*

Dear Sir:

The Examiner is respectfully requested to approve the proposed drawing changes highlighted in red on the attached photocopy.

Applicants will submit corrected drawings after receiving a Notice of Allowance for this application, providing that the Examiner approves the proposed change.

Favorable consideration of this request is respectfully requested.

Respectfully submitted,

Date: April 20, 2000

Harness, Dickey & Pierce, P.L.C.
P.O. Box 828
Bloomfield Hills, MI 48303
(248) 641-1600
GGG/BEW/msm

By: *G. Gregory Schiyley*

G. Gregory Schiyley, Reg. No. 27,382
Bryant E. Wade, Reg. No. 40,344

~~Fig. 11~~

Fig. 11(A)

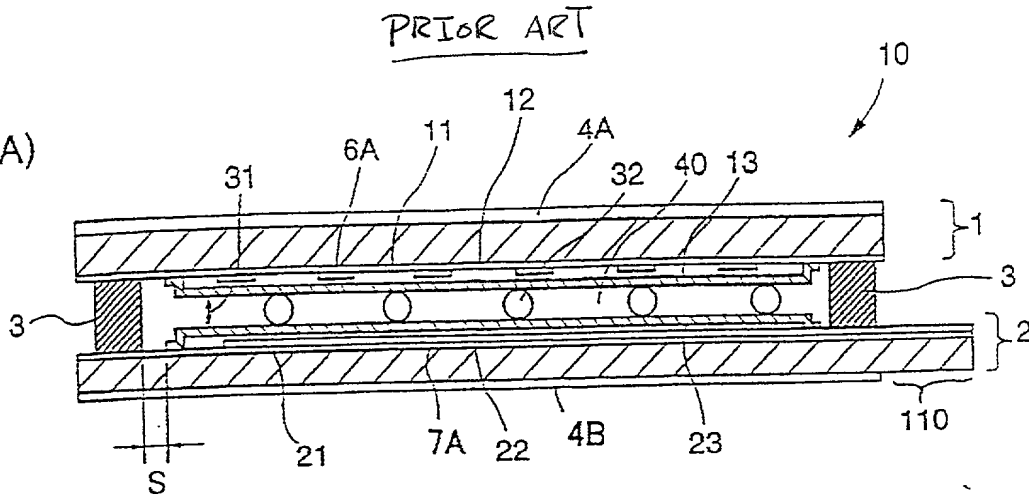
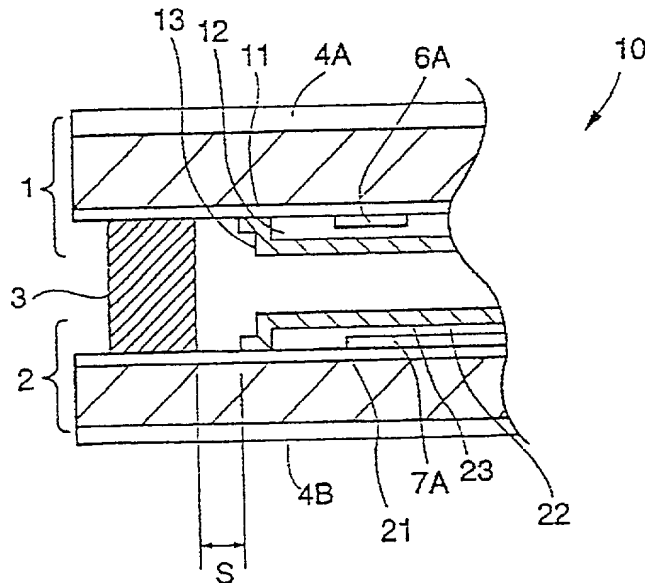


Fig. 11(B)

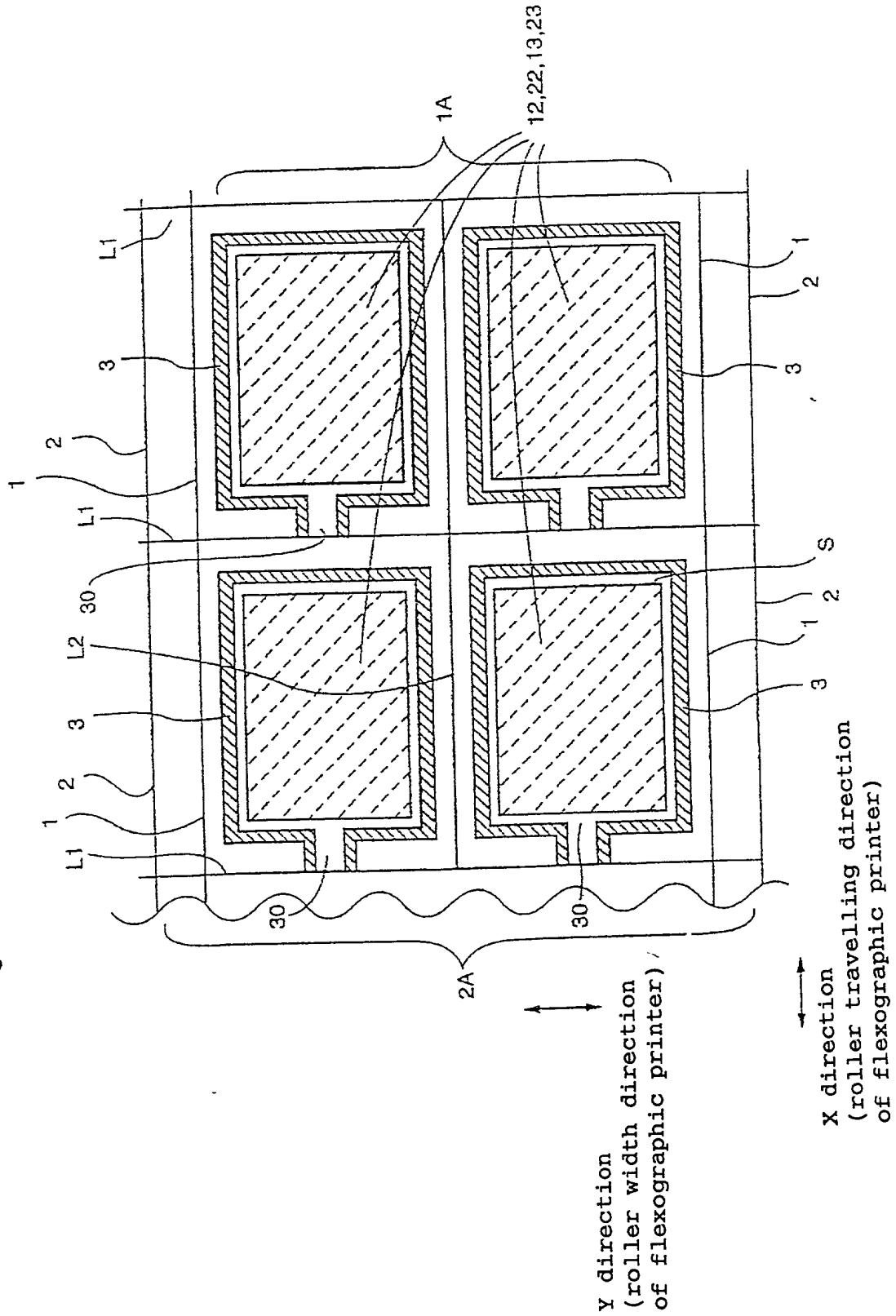


PRIOR ART

Fig. 12

PRIOR ART

Fig. 12



- 1 -

DESCRIPTION

LIQUID CRYSTAL PANEL AND METHOD OF FABRICATING THE SAMETechnical Field

The present invention relates to liquid crystal panels used for liquid crystal display devices and methods of fabricating the same. More particularly, the invention relates to fabricating techniques for the individual substrates constituting the liquid crystal panels.

Background Art

As shown in Figs. 11(A) and 11(B), a first substrate 1 and a second substrate 2 constituting a liquid crystal panel 10 are bonded to each other by a sealant 3 with spacers 32 therebetween, leaving a predetermined gap. A liquid crystal 40 is enclosed in a gap 31. Polarizers 4A and 4B are attached to the first and second substrates 1 and 2, respectively. On the inner surface of the first substrate 1, electrodes 6A, which are composed of ITO (Indium Tin Oxide) films as transparent conductive films or the like for displaying various characters or for displaying dots, are formed on the surface of an underlayer protective film 11, which is composed of a silicon oxide film or the like; and on the inner surface of the second substrate 2, electrodes 7A composed of ITO films for displaying various characters

or for displaying dots are also formed on the surface of an underlayer protective film 21 composed of a silicon oxide film or the like. Transparent insulation films 12 and 22 are formed so as to cover the electrodes 6A and 7A in the first and second substrates 1 and 2, and alignment layers 13 and 23 composed of polyimide films are formed on the surfaces of the transparent insulation films 12 and 22.

The sealant 3 conventionally used is composed of a two-part phenol-novolac-type epoxy resin or two-part aliphatic-type epoxy resin, and if the sealant 3 is brought into contact with the alignment layers 13 and 23 composed of polyimide films, sufficient adhesion does not tend to be obtainable at the interfaces. Therefore, in the conventional liquid crystal panel 10, a space S must be secured between the sealant 3 and the alignment layer 13 and between the sealant 3 and the alignment layer 23, and the following fabrication method has been used. That is, in the fabrication process of the conventional liquid crystal panel 1, as shown in Fig. 12, firstly, electrodes 6A and 7A are formed in the regions for forming the individual substrates, which correspond to single first and second substrates 1 and 2, produced by dividing first and second large substrates 1A and 2A which include a plurality of first and second substrates 1 and 2 to be cut out, and which are obtained by cutting along cutting projection lines L1 and L2 of the

large substrates 1A and 2A. The transparent insulation films 12 and 22 are then formed in the regions (the regions marked by slanted broken lines in Fig. 12) that are slightly inside the regions for forming the sealant 4. Next, the alignment layers 13 and 23 (polyimide films) are formed by flexographic printing so as to be superposed on the transparent insulation films 12 and 22. On one of the first and second large substrates 1A and 2A, the sealant 3 is formed so as to surround the regions for forming alignment layers 13 and 23 in the periphery, and the first and second large substrates 1A and 2A are bonded to each other with the sealant 3. Next, after the bonded first and second large substrates 1A and 2A are separated into single panels or into strip panels, a liquid crystal is injected under reduced pressure from an opening 30 of the sealant 3, and the opening 30 of the sealant 3 is then closed.

However, in the conventional liquid crystal panel 1, as shown in Fig. 11(B), since there is the space S between the sealant 3 and the alignment layer 13 or 23, a low twist domain occurs in the liquid crystal 40 in the section corresponding to the space S. Since the low twist domain degrades the display quality, such a region cannot be used as the region for displaying images. Consequently, the effective region for displaying images is reduced. If the alignment layers 13 and 23 are formed by flexographic

printing so as to be brought as close as possible to the region for forming the sealant 3 (the region marked by slanted solid lines), the region in which the low twist domain occurs can be reduced. However, even if the accuracy of a flexographic printer is increased, it is not possible to control the printing region (the region marked by slanted broken lines in Fig. 12) of the alignment layers 13 and 23 in a roller travelling direction (the direction shown by an arrow X in Fig. 12) so as to reduce the space S in which the low twist domain occurs. Although, in the width direction of a roller used for flexographic printing (the direction shown by an arrow Y in Fig. 12), the printing region can be easily controlled in comparison with that in the roller travelling direction, yet it is impossible to narrow the region in which the low twist domain occurs beyond a certain amount.

In view of the problems described above, it is an object of the present invention to provide a liquid crystal panel in which the region for displaying images can be enlarged by preventing the low twist domain occurring in the space region between alignment layers and a sealant.

Disclosure of Invention

In order to overcome the problems described above, in accordance with the present invention, a liquid crystal

panel includes a pair of rectangular substrates bonded to each other by a sealant with a predetermined gap therebetween, a liquid crystal enclosed in the region delimited by the sealant between the pair of substrates, and electrodes formed on each of the pair of substrates for controlling the alignment state of the liquid crystal. Each of the pair of substrates is provided with an alignment layer formed on the electrode-side surface, the alignment layer being formed up to the region overlapping the region for forming the sealant in the sections corresponding to at least three sides of the substrate provided with the alignment layer.

In accordance with the present invention, since the alignment layer is formed up to the region overlapping the region for forming the sealant, there is no space between the sealant and the alignment layer. Therefore, a low twist domain does not occur in the vicinity of the inner periphery of the sealant. Thus, since the vicinity of the inner periphery of the sealant can be used effectively, the region for displaying images can be enlarged.

In the liquid crystal panel in the present invention, the sealant may be a one-part thermosetting epoxy sealant having good adhesion to a polyimide film used as an alignment layer.

In accordance with the present invention, since the

one-part thermosetting epoxy sealant has good adhesion to the polyimide film used as the alignment layer, and in particular, since a one-part thermosetting epoxy sealant mixed with a high-impact epoxy, in which an acrylic rubber or silicone rubber is polymerized by graft polymerization to an epoxy resin, has excellent adhesion to the polyimide film, even if the sealant is formed so as to overlap the surface of the alignment layer, satisfactory water-tightness and airtightness can be secured at the interface.

In the liquid crystal panel in the present invention, the alignment layer may be formed up to the region overlapping the region for forming the sealant in the sections corresponding to four sides of the substrate.

In the liquid crystal panel in the present invention, the alignment layer may be formed up to the edges of the substrate across the region for forming the sealant in the individual sides of the substrate excluding the side provided with input-output terminals and terminals for conducting between substrates.

In the liquid crystal panel in the present invention, a transparent insulation film for covering the electrodes on the lower layer side of the alignment layer may be formed in the region substantially overlapping the region for forming the alignment layer.

A method of fabricating the liquid crystal panel in

accordance with the present invention includes the step of forming the electrodes on the surface of a large substrate for forming a plurality of pairs of substrates in the individual regions for forming the substrates which correspond to the pair of substrates obtained by cutting the large substrate along cutting projection lines, and the step of forming thin films for forming the alignment layers up to the regions for overlapping the regions for forming the sealant at least in the sections corresponding to three sides of the regions for forming the corresponding substrates.

The method of fabricating the liquid crystal panel in accordance with the present invention may include the step of forming the electrodes on the surface of a large substrate for forming a plurality of pairs of substrates in the individual regions for forming the substrates which correspond to the pair of substrates obtained by cutting the large substrate along cutting projection lines, and the step of forming thin films for forming the alignment layers, respectively, on a plurality of substrate forming-regions including the cutting projection lines.

The method of fabricating the liquid crystal panel in accordance with the present invention may include the step of forming the electrodes on the surfaces of a pair of large substrates for forming a plurality of pairs of substrates in

the regions for forming the individual substrates which correspond to the pair of substrates obtained by cutting the large substrates along cutting projection lines, the step of forming thin films for forming the alignment layers on the plurality of substrate forming-regions including the cutting projection lines in each of the pair of large substrates, the step of forming the sealant on at least one of the pair of large substrates to bond the large substrates to each other, and the step of cutting the bonded large substrates along the cutting projection lines.

In the method of fabricating the liquid crystal panel in accordance with the present invention, in the large substrate, the substrate forming-regions may be placed with a cutting projection line therebetween so that the sides provided with input-output terminals and terminals for conducting between substrates are directed in the opposite directions, and when the thin films for forming the alignment layers are formed, the thin films are formed in strip along the cutting projection line. If the thin films for forming the alignment layers are formed in strip, in flexographic printing, the end of a roller is directed to the side provided with input-output terminals and terminals for conducting between substrates. In such a width direction of the roller, differing from that in the travelling direction of the roller, the printing regions can

be controlled with high accuracy to a certain extent, and in the width direction, even when the alignment layer cannot be formed up to the edge of the substrate, the alignment layer can be formed so as to be substantially adjacent to the region for forming the sealant, or to overlap the region for forming the sealant.

Brief Description of the Drawings

Fig. 1 is a perspective view of a liquid crystal display device.

Fig. 2 is an exploded perspective view of a liquid crystal panel used in the liquid crystal display device shown in Fig. 1.

Fig. 3 is a plan view which shows the configuration pattern of transparent electrodes formed on a first substrate of the liquid crystal panel shown in Fig. 1.

Fig. 4 is a plan view which shows the configuration pattern of transparent electrodes formed on a second substrate of the liquid crystal panel shown in Fig. 1.

Figs. 5(A) and 5(B) are a sectional view of the liquid crystal panel shown in Fig. 1 and an enlarged sectional view of the end thereof, respectively.

Fig. 6 is a plan view of the liquid crystal panel shown in Fig. 1, schematically showing the relationship between the regions for forming alignment layers and the regions for

forming a sealant.

Fig. 7 is a schematic diagram which shows first and second large substrates for forming a plurality of first and second substrates, respectively, regions for forming transparent insulation films and alignment layers (regions marked by broken lines slanting to the left) formed on the first and second large substrates, and regions for forming the sealant (regions marked by solid lines slanting to the right) in the fabrication process of the liquid crystal panel shown in Fig. 1.

Fig. 8 is a schematic diagram which shows first and second large substrates for forming a plurality of first and second substrates, respectively, regions for forming transparent insulation films and alignment layers (regions marked by broken lines slanting to the left) formed on the first and second large substrates, and regions for forming the sealant (regions marked by solid lines slanting to the right) in the fabrication process of a liquid crystal panel in accordance with a second embodiment of the present invention.

Fig. 9 is a schematic diagram which shows first and second large substrates for forming a plurality of first and second substrates, respectively, regions for forming transparent insulation films and alignment layers (regions marked by broken lines slanting to the left) formed on the

first and second large substrates, and regions for forming the sealant (regions marked by solid lines slanting to the right) in the fabrication process of a liquid crystal panel in accordance with a third embodiment of the present invention.

Fig. 10 is a schematic diagram which shows first and second large substrates for forming a plurality of first and second substrates, respectively, regions for forming transparent insulation films and alignment layers (regions marked by broken lines slanting to the left) formed on the first and second large substrates, and regions for forming the sealant (regions marked by solid lines slanting to the right) in the fabrication process of a liquid crystal panel in accordance with a fourth embodiment of the present invention.

Figs. 11(A) and 11(B) are a sectional view of a conventional liquid crystal panel and an enlarged sectional view of the end thereof, respectively.

Fig. 12 is a schematic diagram which shows first and second large substrates for forming a plurality of first and second substrates, respectively, regions for forming transparent insulation films and alignment layers (regions marked by lines slanting to the left) formed on the first and second large substrates, and regions for forming the sealant (regions marked by lines slanting to the right) in

the fabrication process of the conventional liquid crystal panel shown in Figs. 11(A) and 11(B).

Best Mode for Carrying Out the Invention

Embodiments of the present invention will be described below with reference to the accompanying drawings.

{FIRST EMBODIMENT}

(General Structure)

Fig. 1 is a perspective view of a liquid crystal display device and Fig. 2 is an exploded perspective view thereof. In Figs. 1 and 2, only portions of wiring patterns and terminals are shown, and the details thereof are shown in Figs. 3 and 4.

In Figs. 1 and 2, a liquid crystal panel 10 of a liquid crystal display device mounted on an electronic apparatus such as a cordless telephone includes a first substrate 1 composed of transparent glass or the like and a second substrate 2 also composed of transparent glass or the like. A sealant 3 containing gap fillers and conductive particles is formed on one of the substrates by printing or the like, and the first substrate 1 and the second substrate 2 are bonded to each other with the sealant 3 therebetween. In this state, a predetermined gap is maintained between the first substrate 1 and the second substrate 2 by the gap fillers contained in the sealant 3, and a liquid crystal 40

is enclosed in the gap in a liquid crystal filling-region 41 which is delimited by the sealant 3. A polarizer 4A is attached to the outer surface of the first substrate 1 by an adhesive or the like, and a polarizer 4B is attached to the outer surface of the second substrate 2 by an adhesive or the like. When the liquid crystal panel 10 is fabricated as a reflection type, a reflector (not shown in the drawing) is attached to the exterior of the polarizer 4B attached to the second substrate 2 or is attached instead of the polarizer 4B.

In this embodiment, since the second substrate 2 is larger than the first substrate 1, when the first substrate 1 is overlaid on the second substrate 2, a portion of the second substrate 2 protrudes from the lower edge of the first substrate 1. In a protruding section 110, an IC mounting region 9 is formed, and a driver IC 33 is mounted thereon by a COG (Chip On Glass) method.

In the second substrate 2, a plurality of input-output terminals 7D are formed along the edge of the substrate so as to adjoin the IC mounting region 9 on the lower edge side of the IC mounting region 9. A flexible substrate 29 is connected to the input-output terminals 7D, as shown by two-dot chain lines in Fig. 1.

Figs. 3 and 4 are plan views which show the configuration patterns of transparent electrodes formed on

the first substrate 1 and the second substrate 2, respectively.

In Fig. 3, an electrode pattern 6, which is provided with electrodes 6A for displaying characters or for displaying dots and terminals 6C for conducting between substrates lying along a side 101 in order to obtain conduction to the second substrate 2 in the exterior to the liquid crystal filling-region 41, is formed on the inner surface of the first substrate 1. The electrode pattern 6 is composed of an ITO film or the like.

In Fig. 4, an electrode pattern 7, which is provided with electrodes 7A for displaying characters or for displaying dots and a wiring section 7B for wiring the electrodes 7A toward the IC mounting region 9 in the exterior of the liquid crystal filling-region 41, and terminals 7C for conducting between substrates lying along a side 201 in order to obtain conduction to the first substrate 1 in the exterior of the liquid crystal filling-region 41, is formed. The electrode pattern 7 is also composed of an ITO film or the like.

When the first substrate 1 and the second substrate 2 having the structures as described above are bonded to each other as shown in Fig. 1 and Figs. 5(A) and 5(B), since the terminals 6C of the first substrate 1 and the terminals 7C of the second substrate 2 are opposed to each other, the

conductive particles contained in the sealant 3 interposed between the terminals 6C and 7C electrically connect the terminals 6C and 7C, and thus conduction between the first substrate 1 and the second substrate 2 is enabled. That is, the conductive particles contained in the sealant 3 are composed of elastically deformable plastic beads which are subjected to nickel plating or gold plating, and have particle sizes of approximately 5 to 9 μm . In contrast, the gap fillers contained in the sealant 3 have particle sizes of approximately 4 to 8 μm . Therefore, when the sealant 3 is melted and cured while the first substrate 1 is superposed on the second substrate 2 and pressure is applied so as to narrow the gap, the conductive particles, in a squeezed state between the first substrate 1 and the second substrate 2, electrically connect the terminals 6C of the first substrate 1 to the terminal 7C of the second substrate 2.

Since electrodes 6A of the first substrate 1 and the electrodes 7A of the second substrate 2 are opposed to each other when the first substrate 1 and the second substrate 2 are bonded to each other, by applying an electric field to the liquid crystal 40 with the electrodes 6A and 7A, the alignment state of the liquid crystal 40 can be controlled, and desired images can be displayed on the liquid crystal panel 10.

(Structures of transparent insulation films and alignment layers)

Figs. 5(A) and 5(B) are a sectional view of the liquid crystal panel shown in Fig. 1 and an enlarged sectional view of the end thereof, respectively. Fig. 6 is a plan view of the liquid crystal panel shown in Fig. 1, schematically showing the relationship between the regions for forming alignment layers and the regions for forming the sealant.

In the liquid crystal panel 10 having such a structure, as shown in Figs. 5(A) and 5(B), in the first substrate 1 and the second substrate 2, transparent insulation films 12 and 22 are formed so as to cover the electrodes 6A and 7A, and on the surface of the transparent insulation films 12 and 22, alignment layers 13 and 23 composed of polyimide films are formed. The alignment layers 13 and 23 are the polyimide films which are subjected to rubbing treatment, and the liquid crystal 40 is used in STN (Super Twisted Nematic) mode.

As shown in Figs. 5(A) and 5(B) and Fig. 6 (the regions for forming alignment layers 13 and 23 and transparent insulation films 12 and 22 are shown by slanted broken lines, and the regions for forming the sealant 3 are shown by slanted solid lines), in both the first substrate 1 and the second substrate 2, the transparent insulation films 12 and 22 and the alignment layers 13 and 23 are formed up to the

region overlapping the region for forming the sealant 3 in the sections corresponding to four sides 101 to 104 and 201 to 204 of the first and second substrates 1 and 2, respectively.

As the sealant 3, in this embodiment, a one-part thermosetting epoxy sealant, which has good adhesion even to polyimide films constituting the alignment layers 13 and 23, is used. For example, Structbond ES series (trade name) manufactured by Mitsui Toatsu Kagaku K.K. is used. In the one-part thermosetting epoxy sealant, a latent curing agent, such as dicyandiamide, a dihydrazide, or an imidazole, is dispersed in an epoxy resin, and an inorganic filler, a solvent, a viscosity modifier, etc. are further mixed thereto. To this system, a high-impact epoxy in which an acrylic or silicone rubber is polymerized by graft polymerization to an epoxy resin (technique for producing high impact epoxy) is mixed. Therefore, among one-part thermosetting epoxy sealants, since the Structbond ES series manufactured by Mitsui Toatsu Kagaku K.K. has excellent adhesion even to polyimide films, even if the sealant 3 is formed so as to overlap the surface of the alignment layers 13 and 23, excellent water-tightness and airtightness are demonstrated at the interfaces.

When the regions for forming the alignment layers 13 and 23 are defined, since terminals 6C for conducting to the

second substrate 2 are formed in the section corresponding to the side 101 of the first substrate 1, and terminals 7C for conducting to the first substrate 1 and the input-output terminals 7D are formed in the section corresponding to the side 201 of the second substrate 2, if the terminals 6C, 7C, and 7D are covered with the alignment layers 13 and 23, electrical continuity cannot be obtained. Thus, in this embodiment, with respect to the four sides 101 to 104 and 201 to 204 of the first and second substrates 1 and 2, in the sections corresponding to the sides 101 and 201 in which the terminals 6C and 7C for conduction and the input-output terminals 7D are formed, the alignment layers 13 and 23 are formed so as to partially overlap the regions for forming the sealant 3, and in the sections corresponding to the other three sides 102 to 104 and 202 to 204, the alignment layers 13 and 23 are formed up to the edges of the first and second substrates 1 and 2.

The transparent insulation films 12 and 22, which are formed so as to cover the electrodes 6C and 7C, are formed so as to substantially overlap the alignment layers 13 and 23. That is, with respect to the transparent insulation films 12 and 22, if the terminals 6C and 7C for conduction and the input-output terminals 7D of the first and second substrates 1 and 2 are covered, electrical continuity cannot be obtained. Thus, with respect to the four sides 101 to

104 and 201 to 204 of the first and second substrates 1 and 2, in the sections corresponding to the sides 101 and 201 in which the terminals 6C and 7C for conduction and the input-output terminals 7D are formed, the transparent insulation films 12 and 22 are formed so as to partially overlap the regions for forming the sealant 3, and in the sections corresponding to the other three sides 102 to 104 and 202 to 204, the transparent insulation films 12 and 22 are formed up to the edges of the first and second substrates 1 and 2.

Therefore, in the liquid crystal panel 10 in this embodiment, as shown in Fig. 5(B), since there is no space between the sealant 3 and the alignment layers 13 and 23, a low twist domain does not occur in the liquid crystal 40 in the vicinity of the inner periphery of the sealant 3. Consequently, since the vicinity of the inner periphery of the sealant 3 can be also used as the effective region for displaying images, the region for displaying images can be enlarged.

(Method of Fabricating Liquid Crystal Panel)

A method of fabricating the liquid crystal panel 10 having such a structure will be described with reference to Figs. 5(A), 5(B), and 7. Fig. 7 is a schematic diagram which shows the first and second large substrates 1A and 2A for forming a plurality of first and second substrates 1 and 2, respectively, regions for forming the transparent

insulation films 12 and 22 and the alignment layers 13 and 23 formed on the first and second large substrates 1A and 2A, and regions for forming the sealant 3 in the fabrication process of the liquid crystal panel shown in Fig. 1. In Fig. 7, since the first and second large substrates 1A and 2A for forming a plurality of first and second substrates 1 and 2, respectively, regions for forming the transparent insulation films 12 and 22 and the alignment layers 13 and 23 (regions marked by slanted broken lines) in relation to the first and second large substrates 1A and 2A, and regions for forming the sealant 3 (regions marked by slanted solid lines) are shown and other components are omitted, the individual components to be formed on the first and second large substrates 1A and 2A will be described with reference to Figs. 5(A) and 5(B).

First, as shown in Figs. 5(A) and 5(B) and Fig. 7, after underlayer protective films 11 and 21 are formed over the surfaces of the first and second large substrates 1A and 2A for forming a plurality of first and second substrates 1 and 2, respectively, electrode patterns 6 and 7 including the electrodes 6A and 7A and the terminals 6C and 7C are formed by photolithography in the individual substrate forming-regions, which are to be separated into the first and second substrates 1 and 2 by cutting the large substrates 1A and 2A along the cutting projection lines L1

and L2.

Next, with respect to the first and second large substrates 1A and 2A, transparent insulation films 12 and 22 composed of silicon oxide films are formed so as to cover the electrodes 6A and 7A. The transparent insulation films 12 and 22 are formed in strip covering a plurality of substrate forming-regions including the cutting projection lines L1 and L2. That is, in the first and second large substrates 1A and 2A, the substrate forming-regions are disposed with the cutting projection line L2 therebetween so that the sides 101 and 201, in which the input-output terminals 12 and the terminals 6C and 7C for conducting between substrates are formed, are directed in the opposite directions, the transparent insulation films 12 and 22 are formed in strip along the cutting projection line L2. As a result, when the first and second large substrates 1A and 2A are divided into single first and second substrates 1 and 2 by cutting along the cutting projection lines L1 and L2, in the sections corresponding to the four sides 101 to 104 and 201 to 204 of the first and second substrates 1 and 2, the transparent insulation films 12 and 22 are formed so as to be superposed on the regions for forming the sealant 3. In the sections corresponding to three sides 102 to 104 and 202 to 204, excluding the sides 101 and 201 in which the terminals 6A and 7A for conducting between substrates and

the input-output terminals 7D are formed, among the four sides 101 to 104 and 201 to 204 of the first and second substrates 1 and 2, the transparent insulation films 12 and 22 are formed up to the edges of the first and second substrates 1 and 2 across the regions for forming the sealant 3, and in the sections corresponding to the sides 101 and 201 in which the terminals 6A and 7A for conducting between substrates and the input-output terminals 7D are formed, the transparent insulation films 12 and 22 are formed so as to partially overlap the regions for forming the sealant 3.

Next, polyimide films (alignment layers 13 and 23) are formed by flexographic printing so as to cover the transparent insulation films 12 and 22 in the first and second large substrates 1A and 2A. The polyimide films (alignment layers 13 and 23) are also formed in strip over the plurality of substrate forming-regions including the cutting projection lines L1 and L2. That is, in the first and second large substrates 1A and 2A, since the substrate forming-regions are disposed with the cutting projection line L2 therebetween so that the sides 101 and 201, in which the input-output terminals 7D and terminals 6C and 7C for conducting between substrates are formed, are directed in the opposite directions, the polyimide films (alignment layers 13 and 23) are formed in strip along the cutting

projection line L2 by moving a roller in a flexographic printer along the cutting projection line L2 with the end of the roller being directed toward the sides 101 and 201. As a result, when the first and second large substrates 1A and 2A are divided into single first and second substrates 1 and 2 by cutting along the cutting projection lines L1 and L2, in the sections corresponding to the four sides 101 to 104 and 201 to 204 of the first and second substrates 1 and 2, the polyimide films (alignment layers 13 and 23) are formed so as to be superposed on the regions for forming the sealant 3. In the sections corresponding to three sides 102 to 104 and 202 to 204, excluding the sides 101 and 201 in which the terminals 6A and 7A for conducting between substrates and the input-output terminals 7D are formed, among the four sides 101 to 104 and 201 to 204 of the first and second substrates 1 and 2, the polyimide films (alignment layers 13 and 23) are formed up to the edges of the first and second substrates 1 and 2 across the regions for forming the sealant 3 and in the sections corresponding to the sides 101 and 201 in which the terminals 6A and 7A for conducting between substrates and the input-output terminals 7D are formed, the polyimide films (alignment layers 13 and 23) are formed so as to partially overlap the regions for forming the sealant 3.

Next, rubbing treatment is performed on the first and

second large substrates to form the alignment layers 13 and 23 from the polyimide films.

Next, with respect to the second large substrate 2A, after the sealant 3 is printed on the surfaces of the alignment layers 13 and 23, pre-baking is performed, and then the first large substrate 1A and the second large substrate 2A are bonded to each other with the sealant 3 therebetween. At this stage, as shown in Fig. 5(A), after spacers 32 are scattered on the first large substrate 1, the first large substrate 1A and the second large substrate 2A are bonded to each other.

Again, in Figs. 5(A) and 5(B) and Fig. 7, after the first large substrate 1A and the second large substrate 2A are bonded to each other, the bonded first large substrate 1A and second large substrate 2A are divided into single liquid crystal panels 10 by cutting along the cutting projection lines L1 and L2, or the bonded first large substrate 1A and second large substrate 2A are divided into strip panels by cutting along the cutting projection line L1. In either state of cutting, openings 30 of the sealant 3 are opened in the cut surfaces (corresponding to the sides 104 and 204).

Consequently, when the regions delimited by the sealant 3 in the gap between the first and second substrates 1 and 2 are evacuated and the openings 30 are immersed in the liquid

crystal, by increasing the pressure of the surrounding atmosphere, the liquid crystal 40 is injected into the regions delimited by the sealant 3. Thus, by closing the openings 30 of the sealant 3 after the liquid crystal 40 is injected, the liquid crystal 40 is enclosed in the gap 31 between the first and second substrates 1 and 2.

At this stage, if the single liquid crystal panels 10 are separated, as shown in Fig. 1 and Figs. 5(A) and 5(B), the polarizers 4A and 4B, etc. are attached thereto. On the other hand, if the strip panels are separated, after dividing the strip panels into single liquid crystal panels 10, the polarizers 4A and 4B, etc. are attached thereto.

Next, as shown in Fig. 1, the flexible substrate 29 is pressed onto the input-output terminals 7D of the second substrate 2 using an anisotropic conductive film or the like, and is delivered to the inspection step.

As described above, in accordance with the fabrication method in this embodiment, since the polyimide films are applied all over in the roller travelling direction of a flexographic printer (the direction shown by an arrow X in Fig. 7), even if the printing regions for the alignment layers 13 and 23 cannot be controlled in this direction, spaces do not occur between the sealant 3 and the alignment layer 13 or 23. In the roller width direction in flexographic printing (the direction shown by an arrow Y in

Fig. 7), although it is necessary to control the printing regions so that the alignment layers 13 and 23 do not cover the terminals 6A and 7A for conducting between substrates and the input-output terminals 7D, in such a direction, it is relatively easy to control the printing regions in the flexographic printer, spaces do not occur between the sealant 3 and the alignment layer 13 or 23 also in this direction.

[SECOND EMBODIMENT]

Fig. 8 is a schematic diagram which shows first and second large substrates for forming a plurality of first and second substrates, respectively, regions for forming transparent insulation films and alignment layers (regions marked by broken lines slanting to the left) formed on the first and second large substrates, and regions for forming the sealant (regions marked by solid lines slanting to the right) in the fabrication process of a liquid crystal panel in accordance with a second embodiment of the present invention. Since the basic structure of the liquid crystal panel in this embodiment is in common with that of the liquid crystal panel in accordance with the first embodiment, the same numerals are used for the corresponding sections in Fig. 8, and the detailed description thereof will be omitted.

As shown in Fig. 8, in this embodiment, transparent insulation films 12 and 22 composed of silicon oxide films

are formed on first and second large substrates 1A and 2A so as to cover electrodes 6A and 7A (refer to Figs. 3, 4, 5(A), and 5(B)). Although the transparent insulation films 12 and 22 cover a cutting projection line L1 between cutting projection lines L1 and L2, they do not cover the cutting projection line L2, and the transparent insulation films 12 and 22 are formed in strip by each row, covering a plurality of substrate forming-regions. As a result, when the first and second large substrates 1A and 2A are divided into single first and second substrates 1 and 2 by cutting along the cutting projection lines L1 and L2, in the sections corresponding to the four sides 101 to 104 and 201 to 204 of the first and second substrates 1 and 2, the transparent insulation films 12 and 22 are formed so as to be superposed on the regions for forming the sealant 3. In the sections corresponding to two sides 102 and 104, and 202 and 204, excluding the sides 101 and 201 in which the terminals 6A and 7A for conducting between substrates and the input-output terminals 7D are formed and the sides 103 and 203 lying on the side of the cutting projection line L2, among the four sides 101 to 104 and 201 to 204 of the first and second substrates 1 and 2, the transparent insulation films 12 and 22 are formed up to the edges of the first and second substrates 1 and 2 across the regions for forming the sealant 3.

Next, polyimide films (alignment layers 13 and 23) are formed by flexographic printing so as to cover the transparent insulation films 12 and 22 in the first and second large substrates 1A and 2A. The polyimide films also cover the cutting projection line L1 between the cutting projection lines L1 and L2 and the polyimide films do not cover the cutting projection line L2. The polyimide films are formed in strip by each row over a plurality of substrate forming-regions. As a result, when the first and second large substrates 1A and 2A are divided into single first and second substrates 1 and 2 by cutting along the cutting projection lines L1 and L2, in the sections corresponding to the four sides 101 to 104 and 201 to 204 of the first and second substrates 1 and 2, the polyimide films (alignment layers 13 and 23) are formed so as to be superposed on the regions for forming the sealant 3. In the sections corresponding to two sides 102 and 104, and 202 and 204, excluding the sides 101 and 201 in which the terminals 6A and 7A for conducting between substrates and the input-output terminals 7D are formed and the sides 103 and 203 lying on the side of the cutting projection line L2, among the four sides 101 to 104 and 201 to 204 of the first and second substrates 1 and 2, the polyimide films (alignment layers 13 and 23) are formed up to the edges of the first and second substrates 1 and 2 across the regions for forming

the sealant 3.

[THIRD EMBODIMENT]

Fig. 9 is a schematic diagram which shows first and second large substrates for forming a plurality of first and second substrates, respectively, regions for forming transparent insulation films and alignment layers (regions marked by broken lines slanting to the left) formed on the first and second large substrates, and regions for forming the sealant (regions marked by solid lines slanting to the right) in the fabrication process of a liquid crystal panel in accordance with a third embodiment of the present invention. Since the basic structure of the liquid crystal panel in this embodiment is in common with that of the liquid crystal panel in accordance with the first embodiment, the same numerals are used for the corresponding sections in Fig. 9, and the detailed description thereof will be omitted.

As shown in Fig. 9, in this embodiment, transparent insulation films 12 and 22 composed of silicon oxide films are formed on first and second large substrates 1A and 2A so as to cover electrodes 6A and 7A (refer to Figs. 3, 4, 5(A), and 5(B)). Although the transparent insulation films 12 and 22 cover a cutting projection line L2 between cutting projection lines L1 and L2, they do not cover the cutting projection line L1, and the transparent insulation films 12 and 22 are formed in strip, covering a plurality of

substrate forming-regions. As a result, when the first and second large substrates 1A and 2A are divided into single first and second substrates 1 and 2 by cutting along the cutting projection lines L1 and L2, in the sections corresponding to the four sides 101 to 104 and 201 to 204 of the first and second substrates 1 and 2, the transparent insulation films 12 and 22 are formed so as to be superposed on the regions for forming the sealant 3. In the sections corresponding to the sides 103 and 203 lying on the side of the cutting projection line L2, among the four sides 101 to 104 and 201 to 204 of the first and second substrates 1 and 2, the transparent insulation films 12 and 22 are formed up to the edges of the first and second substrates 1 and 2 across the regions for forming the sealant 3.

Polyimide films (alignment layers 13 and 23) are formed by flexographic printing so as to cover the transparent insulation films 12 and 22 in the first and second large substrates 1A and 2A. The polyimide films (alignment layers 13 and 23) also cover the cutting projection line L2 between the cutting projection lines L1 and L2 and the polyimide films do not cover the cutting projection line L1. The polyimide films are formed in strip over a plurality of substrate forming-regions. As a result, when the first and second large substrates 1A and 2A are divided into single first and second substrates 1 and 2 by cutting along the

cutting projection lines L1 and L2, in the sections corresponding to the four sides 101 to 104 and 201 to 204 of the first and second substrates 1 and 2, the polyimide films (alignment layers 13 and 23) are formed so as to be superposed on the regions for forming the sealant 3. In the sections corresponding to the sides 103 and 203 lying on the side of the cutting projection line L2, among the four sides 101 to 104 and 201 to 204 of the first and second substrates 1 and 2, the polyimide films (alignment layers 13 and 23) are formed up to the edges of the first and second substrates 1 and 2 across the regions for forming the sealant 3.

[FOURTH EMBODIMENT]

Fig. 10 is a schematic diagram which shows first and second large substrates for forming a plurality of first and second substrates, respectively, regions for forming transparent insulation films and alignment layers (regions marked by broken lines slanting to the left) formed on the first and second large substrates, and regions for forming the sealant (regions marked by solid lines slanting to the right) in the fabrication process of a liquid crystal panel in accordance with a fourth embodiment of the present invention. Since the basic structure of the liquid crystal panel in this embodiment is in common with that of the liquid crystal panel in accordance with the first embodiment,

the same numerals are used for the corresponding sections in Fig. 10, and the detailed description thereof will be omitted.

As shown in Fig. 10, in this embodiment, transparent insulation films 12 and 22 composed of silicon oxide films are formed on first and second large substrates 1A and 2A so as to cover electrodes 6A and 7A (refer to Figs. 3, 4, 5(A), and 5(B)). The transparent insulation films 12 and 22 do not cover cutting projection lines L1 and L2, and are formed independently by each substrate forming-region. However, when the first and second large substrates 1A and 2A are divided into single first and second substrates 1 and 2 by cutting along the cutting projection lines L1 and L2, in the sections corresponding to the four sides 101 to 104 and 201 to 204 of the first and second substrates 1 and 2, the transparent insulation films 12 and 22 are formed so as to be superposed on the regions for forming the sealant 3.

Polyimide films (alignment layers 13 and 23) are formed by flexographic printing so as to cover the transparent insulation films 12 and 22 in the first and second large substrates 1A and 2A. The polyimide films (alignment layers 13 and 23) do not cover the cutting projection lines L1 and L2, and are formed independently by each substrate forming-region. However, when the first and second large substrates 1A and 2A are divided into single first and second

substrates 1 and 2 by cutting along the cutting projection lines L1 and L2, in the sections corresponding to the four sides 101 to 104 and 201 to 204 of the first and second substrates 1 and 2, the polyimide films (alignment layers 13 and 23) are formed so as to be superposed on the regions for forming the sealant 3.

{OTHER EMBODIMENTS]

Although, in any one of the embodiments described above, the transparent insulation films 12 and 22 and the polyimide films (alignment layers 13 and 23) are formed so as to be superposed on the regions for forming the sealant 3 at the four sides of the substrate, the transparent insulation films 12 and 22 and the polyimide films (alignment layers 13 and 23) may be superposed on the regions for forming the sealant 3 at least at the three sides of the substrate. For example, the regions for forming the transparent insulation films 12 and 22 and the polyimide films (alignment layers 13 and 23) may be formed in the interior of the regions for forming the sealant 3 at the sides 101 and 201 in which terminals 6A and 7A for conducting between substrates and input-output terminals 7D are formed, among the four sides 101 to 104 and 201 to 204 of the first and second substrates 1 and 2.

Although examples of passive matrix-type liquid crystal panels have been described, the present invention is also

applicable to active matrix-type liquid crystal panels.

Furthermore, although, in accordance with the embodiments, alignment layers, etc. are formed in the stage of large substrates, and after the large substrates are bonded to each other, they are divided into single liquid crystal panels, the present invention is also applicable to the case in which electrodes, alignment layers, etc. are formed on single substrates.

Industrial Applicability

As described above, in liquid crystal panels and methods for fabricating the same in accordance with the present invention, since alignment layers are formed up to the regions overlapping the regions for forming a sealant, there is no space between the sealant and the alignment layers. Therefore, a low twist domain does not occur in the vicinity of the inner periphery of the sealant, and the vicinity of the inner periphery of the sealant can be effectively used as the region for displaying images. Accordingly, the present invention is useful for liquid crystal display devices which require wider regions for displaying images and methods of fabricating the same, and in particular, the invention is suitable for a liquid crystal display device in which a larger amount of displaying is required by effectively using the limited

4

Country	Year	Population (millions)	Urban population (millions)	Urban population (%)	Population density (per sq km)	Urban population density (per sq km)	Population growth rate (%)	Urban population growth rate (%)	Population growth rate (%)	Urban population growth rate (%)	Population growth rate (%)	Urban population growth rate (%)
Algeria	1980	10.0	4.0	40.0	100	250	1.5	2.5	1.5	2.5	1.5	2.5
Algeria	1985	10.5	4.5	42.9	105	263	1.8	2.8	1.8	2.8	1.8	2.8
Algeria	1990	11.0	5.0	45.5	110	276	2.1	3.1	2.1	3.1	2.1	3.1
Algeria	1995	11.5	5.5	47.8	115	289	2.4	3.4	2.4	3.4	2.4	3.4
Algeria	2000	12.0	6.0	50.0	120	302	2.7	3.7	2.7	3.7	2.7	3.7
Algeria	2005	12.5	6.5	52.0	125	315	3.0	4.0	3.0	4.0	3.0	4.0
Algeria	2010	13.0	7.0	53.8	130	328	3.3	4.3	3.3	4.3	3.3	4.3
Algeria	2015	13.5	7.5	55.6	135	341	3.6	4.6	3.6	4.6	3.6	4.6
Algeria	2020	14.0	8.0	57.1	140	354	3.9	4.9	3.9	4.9	3.9	4.9
Algeria	2025	14.5	8.5	58.6	145	367	4.2	5.2	4.2	5.2	4.2	5.2
Algeria	2030	15.0	9.0	60.0	150	380	4.5	5.5	4.5	5.5	4.5	5.5
Algeria	2035	15.5	9.5	61.3	155	393	4.8	5.8	4.8	5.8	4.8	5.8
Algeria	2040	16.0	10.0	62.5	160	406	5.1	6.1	5.1	6.1	5.1	6.1
Algeria	2045	16.5	10.5	63.6	165	419	5.4	6.4	5.4	6.4	5.4	6.4
Algeria	2050	17.0	11.0	64.7	170	432	5.7	6.7	5.7	6.7	5.7	6.7
Algeria	2055	17.5	11.5	65.7	175	445	6.0	7.0	6.0	7.0	6.0	7.0
Algeria	2060	18.0	12.0	66.7	180	458	6.3	7.3	6.3	7.3	6.3	7.3
Algeria	2065	18.5	12.5	67.6	185	471	6.6	7.6	6.6	7.6	6.6	7.6
Algeria	2070	19.0	13.0	68.4	190	484	6.9	7.9	6.9	7.9	6.9	7.9
Algeria	2075	19.5	13.5	69.2	195	497	7.2	8.2	7.2	8.2	7.2	8.2
Algeria	2080	20.0	14.0	70.0	200	510	7.5	8.5	7.5	8.5	7.5	8.5
Algeria	2085	20.5	14.5	70.7	205	523	7.8	8.8	7.8	8.8	7.8	8.8
Algeria	2090	21.0	15.0	71.4	210	536	8.1	9.1	8.1	9.1	8.1	9.1
Algeria	2095	21.5	15.5	72.1	215	549	8.4	9.4	8.4	9.4	8.4	9.4
Algeria	2100	22.0	16.0	72.7	220	562	8.7	9.7	8.7	9.7	8.7	9.7
Algeria	2105	22.5	16.5	73.3	225	575	9.0	10.0	9.0	10.0	9.0	10.0
Algeria	2110	23.0	17.0	73.9	230	588	9.3	10.3	9.3	10.3	9.3	10.3
Algeria	2115	23.5	17.5	74.5	235	601	9.6	10.6	9.6	10.6	9.6	10.6
Algeria	2120	24.0	18.0	75.0	240	614	9.9	10.9	9.9	10.9	9.9	10.9
Algeria	2125	24.5	18.5	75.5	245	627	10.2	11.2	10.2	11.2	10.2	11.2
Algeria	2130	25.0	19.0	76.0	250	640	10.5	11.5	10.			

CLAIMS

1. A liquid crystal panel comprising a pair of rectangular substrates bonded to each other by a sealant with a predetermined gap therebetween, a liquid crystal enclosed in the region delimited by the sealant between the pair of substrates, and electrodes formed on each of the pair of substrates for controlling the alignment state of the liquid crystal,

wherein each of the pair of substrates is provided with an alignment layer formed on the electrode-side surface, the alignment layer being formed up to the region overlapping the region for forming the sealant in the sections corresponding to at least three sides of the substrate provided with the alignment layer.

2. A liquid crystal panel according to Claim 1, wherein the sealant is a one-part thermosetting epoxy sealant.

3. A liquid crystal panel according to one of Claims 1 and 2, wherein the alignment layer is formed up to the region overlapping the region for forming the sealant in the sections corresponding to four sides of the substrate.

4. A liquid crystal panel according to any one of

Claims 1 to 3, wherein the alignment layer is formed up to the edges of the substrate across the region for forming the sealant in the individual sides of the substrate excluding the side provided with input-output terminals and terminals for conducting between substrates.

5. A liquid crystal panel according to any one of Claims 1 to 4, wherein a transparent insulation film for covering the electrodes on the lower layer side of the alignment layer is formed in the region substantially overlapping the region for forming the alignment layer.

6. A method of fabricating a liquid crystal panel defined in any one of Claims 1 to 5, wherein the electrodes are formed on the surface of a large substrate for forming a plurality of pairs of substrates in the individual regions for forming the substrates which are divided by cutting the large substrate along cutting projection lines, and then thin films for forming the alignment layers are formed up to the regions for overlapping the regions for forming the sealant in the sections corresponding to at least three sides of the regions for forming the substrates.

7. A method of fabricating a liquid crystal panel according to Claim 6, wherein the electrodes are formed on

the surface of the large substrate for forming a plurality of pairs of substrates in the individual regions for forming the substrates which are divided by cutting the large substrate along cutting projection lines, and then the thin films for forming the alignment layers are formed on a plurality of substrate forming-regions including the cutting projection lines.

8. A method of fabricating a liquid crystal panel according to Claim 7, wherein the electrodes are formed on the surfaces of a pair of large substrates for forming a plurality of pairs of substrates in the regions for forming the individual substrates which are divided by cutting the large substrates along cutting projection lines, the thin films for forming the alignment layers are formed on the plurality of substrate forming-regions including the cutting projection lines in each of the pair of large substrates, the sealant is formed on at least one of the pair of large substrates to bond the large substrates to each other, and the bonded large substrates are cut along the cutting projection lines.

9. A method of fabricating a liquid crystal panel according to one of Claims 7 and 8, wherein, in the large substrate, the substrate forming-regions are placed with a

cutting projection line therebetween so that the sides provided with input-output terminals and terminals for conducting between substrates are directed in the opposite directions, and when the thin films for forming the alignment layers are formed, the thin films are formed in strip along the cutting projection line.

COPIES OF THE

ABSTRACT

In a liquid crystal panel 1 provided with first and second substrates 1 and 2 bonded by a sealant 3, alignment layers 13 and 23 for covering electrodes 6A and 7A, respectively, are formed up to the regions overlapping the regions for forming the sealant 3. Accordingly, since there is no space between the alignment 13 or 23 and the sealant 3, a low twist domain does not occur in a liquid crystal 40. Therefore, the vicinity of the inner periphery of the sealant can also be effectively used as the region for displaying images.

Fig. 1

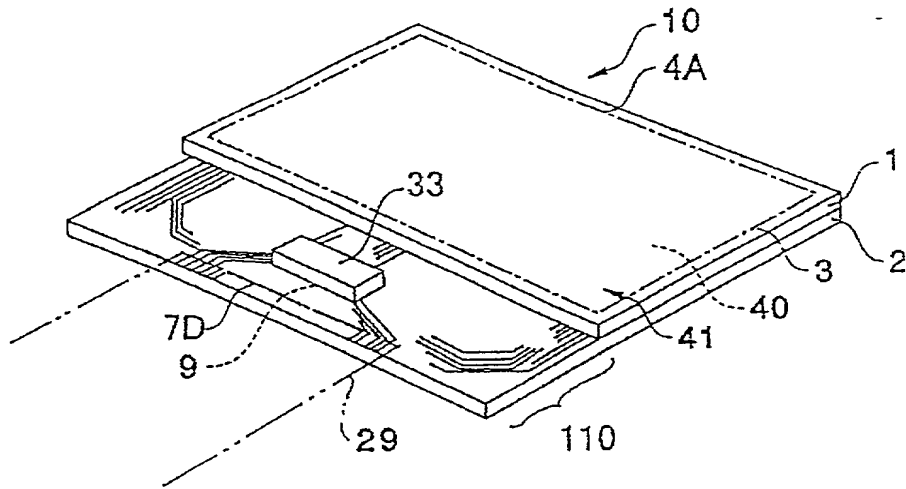


Fig. 2

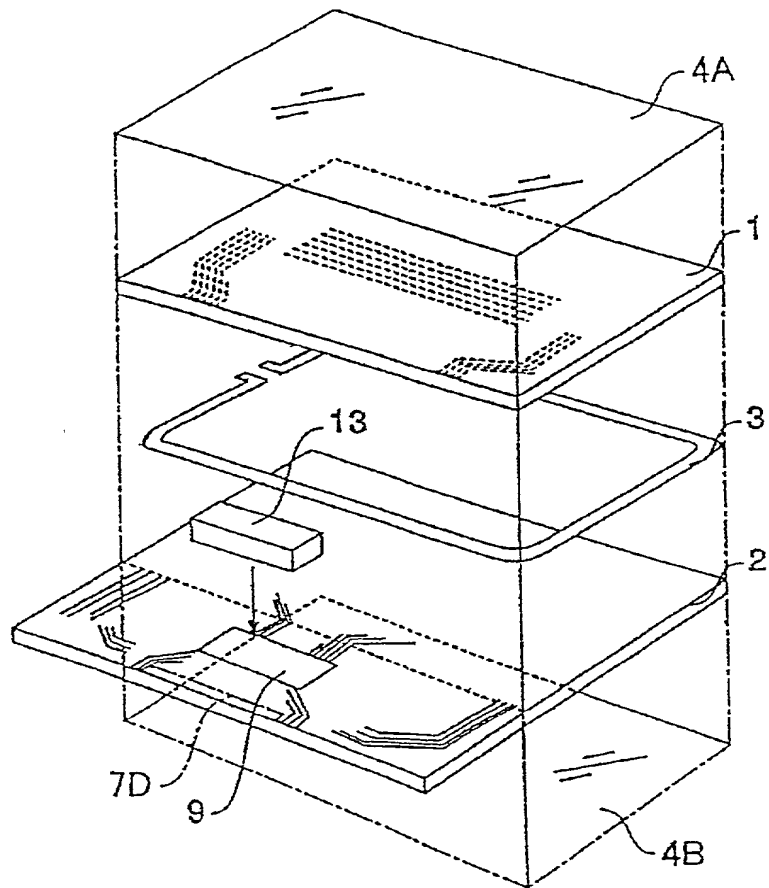


Fig. 3

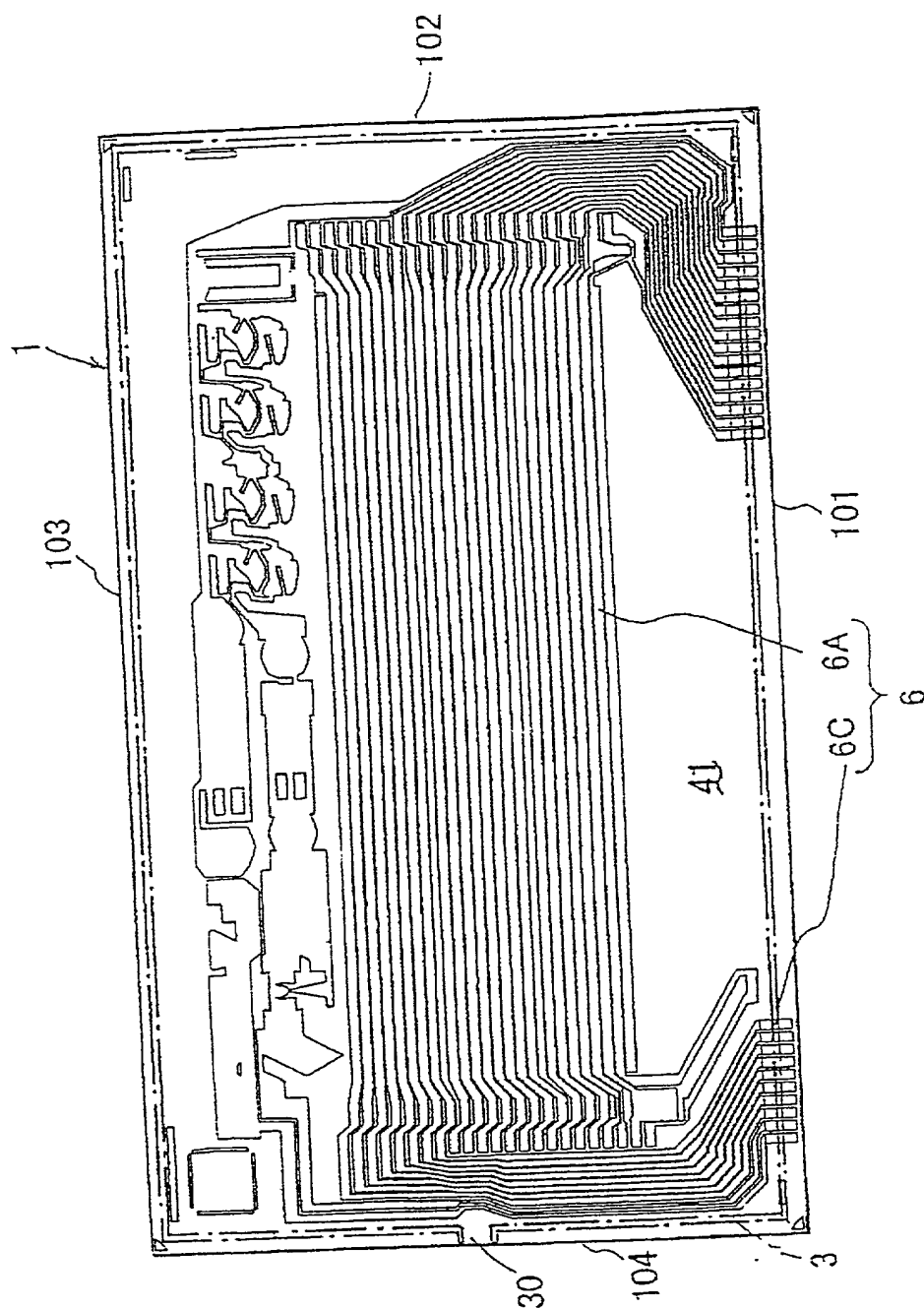


Fig. 4

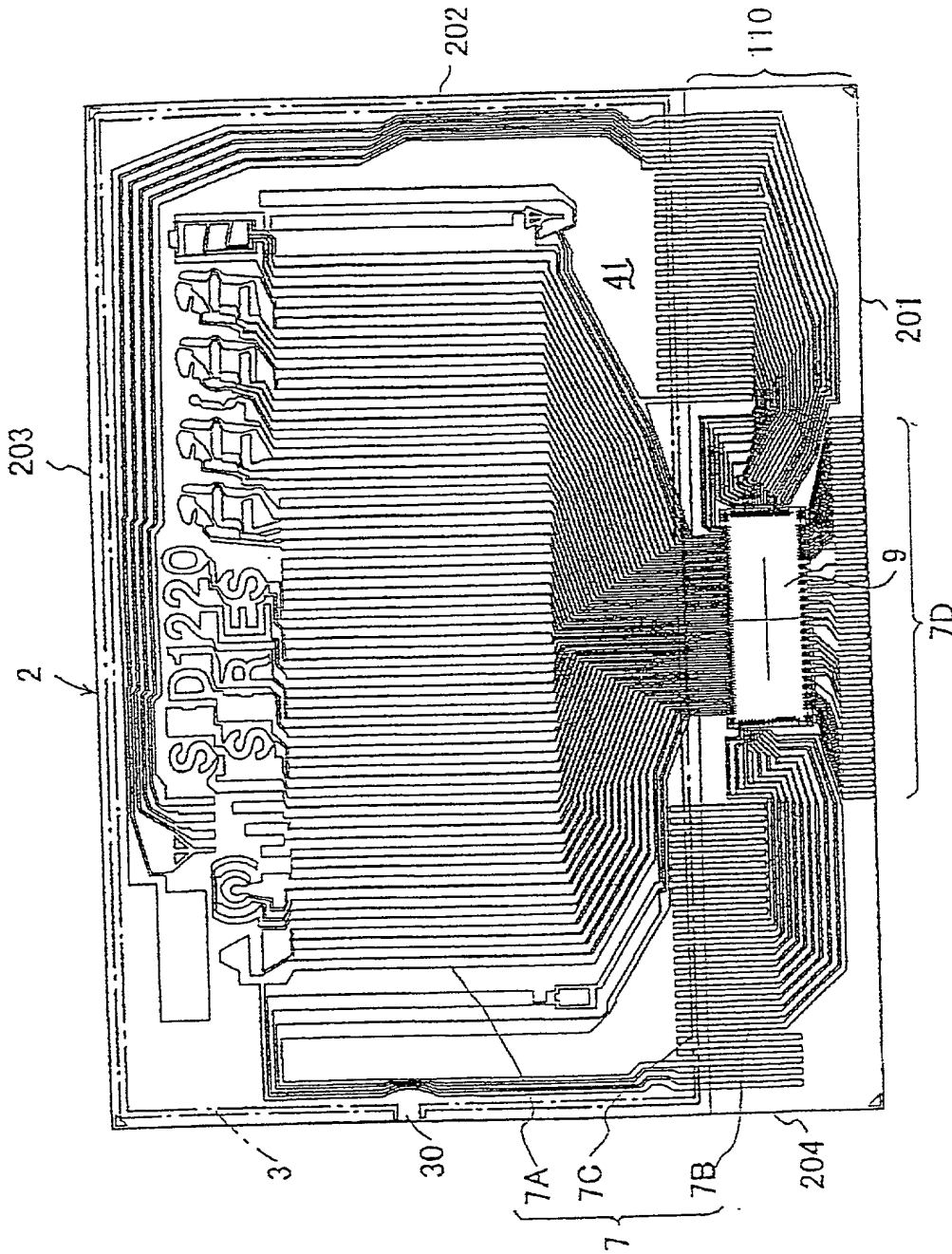


Fig. 5

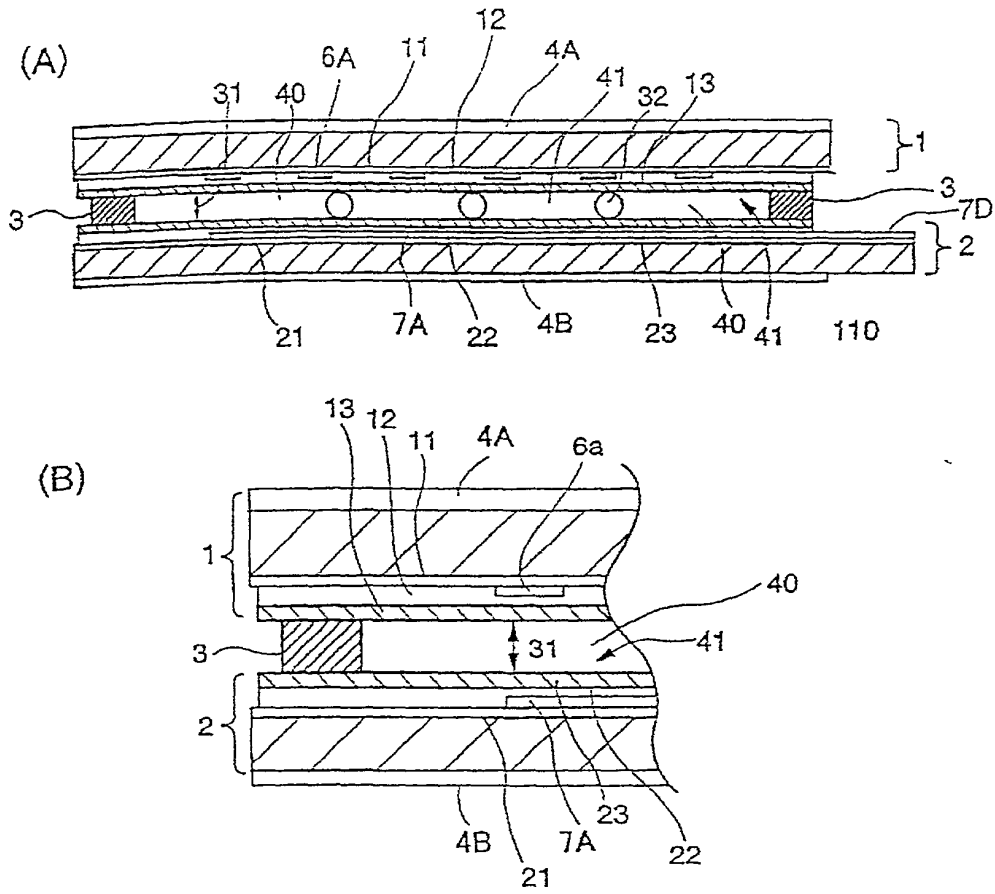
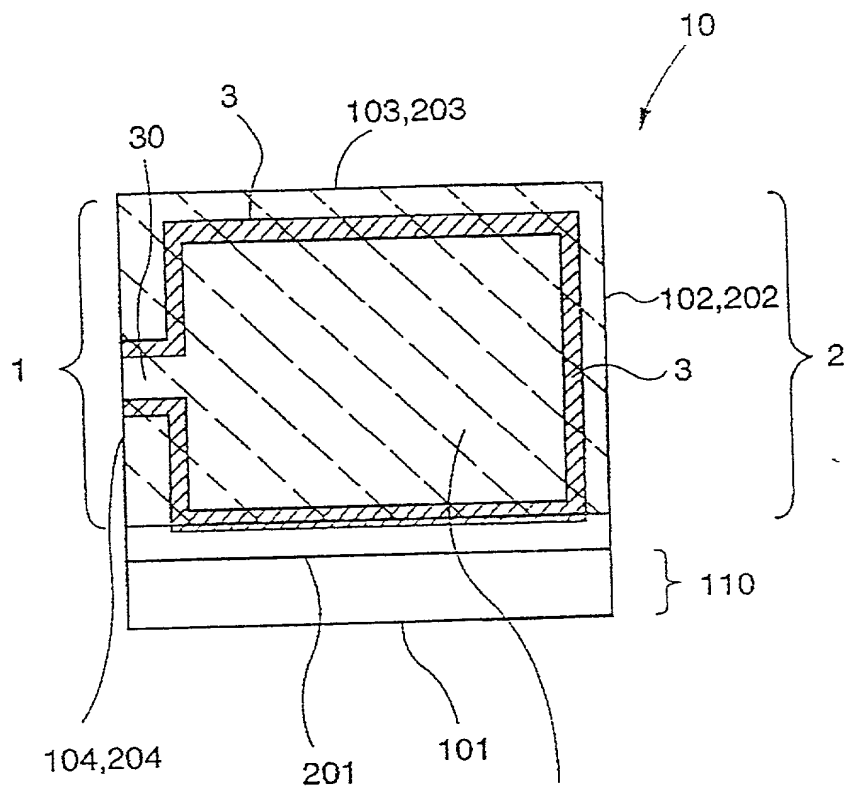
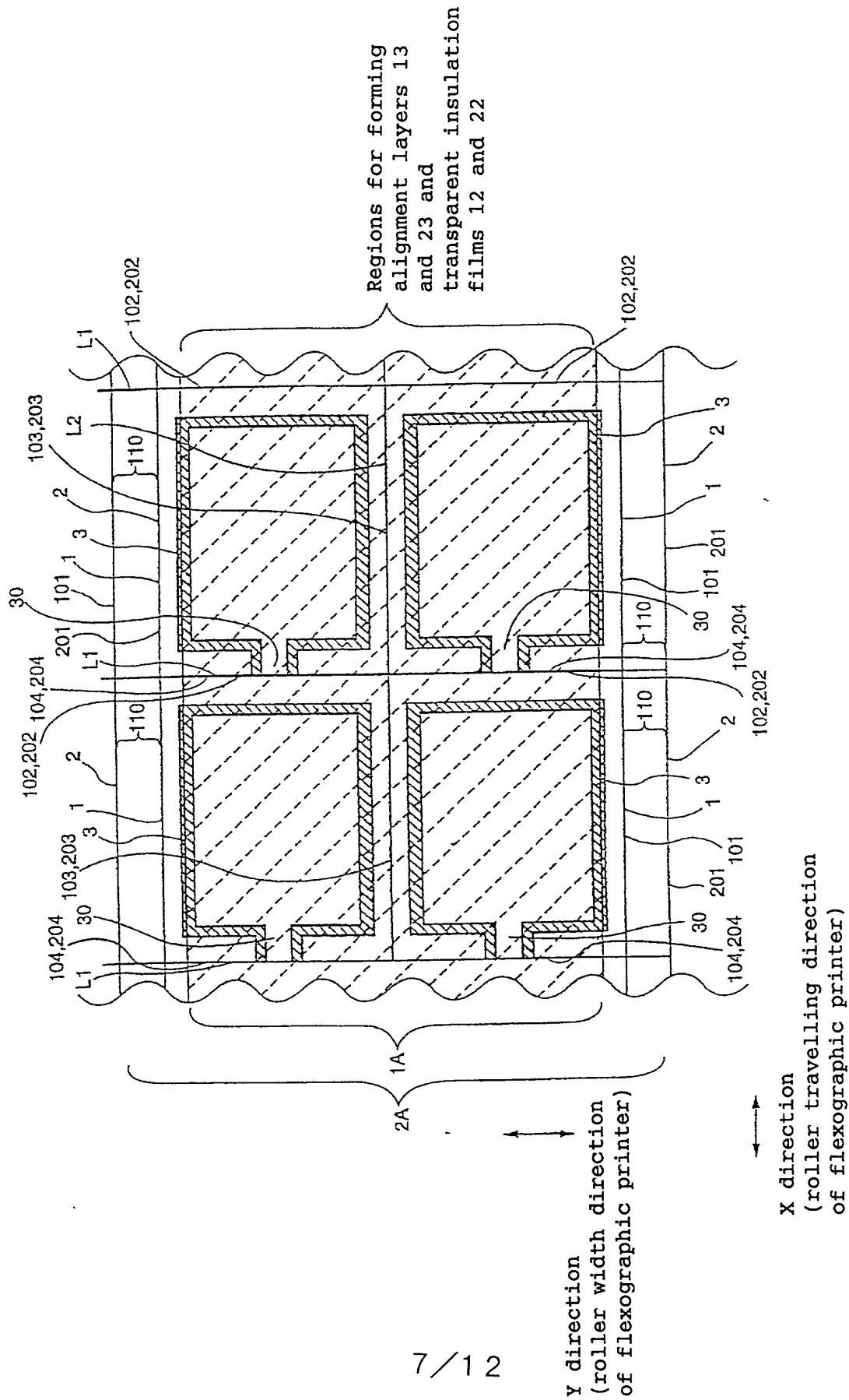


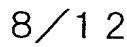
Fig. 6



Regions for forming
alignment layers 13 and 23 and
transparent insulation films 12 and 22



Regions for forming alignment layers 13 and 23 and transparent insulation films 12 and 22



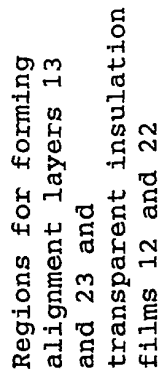


Fig. 10

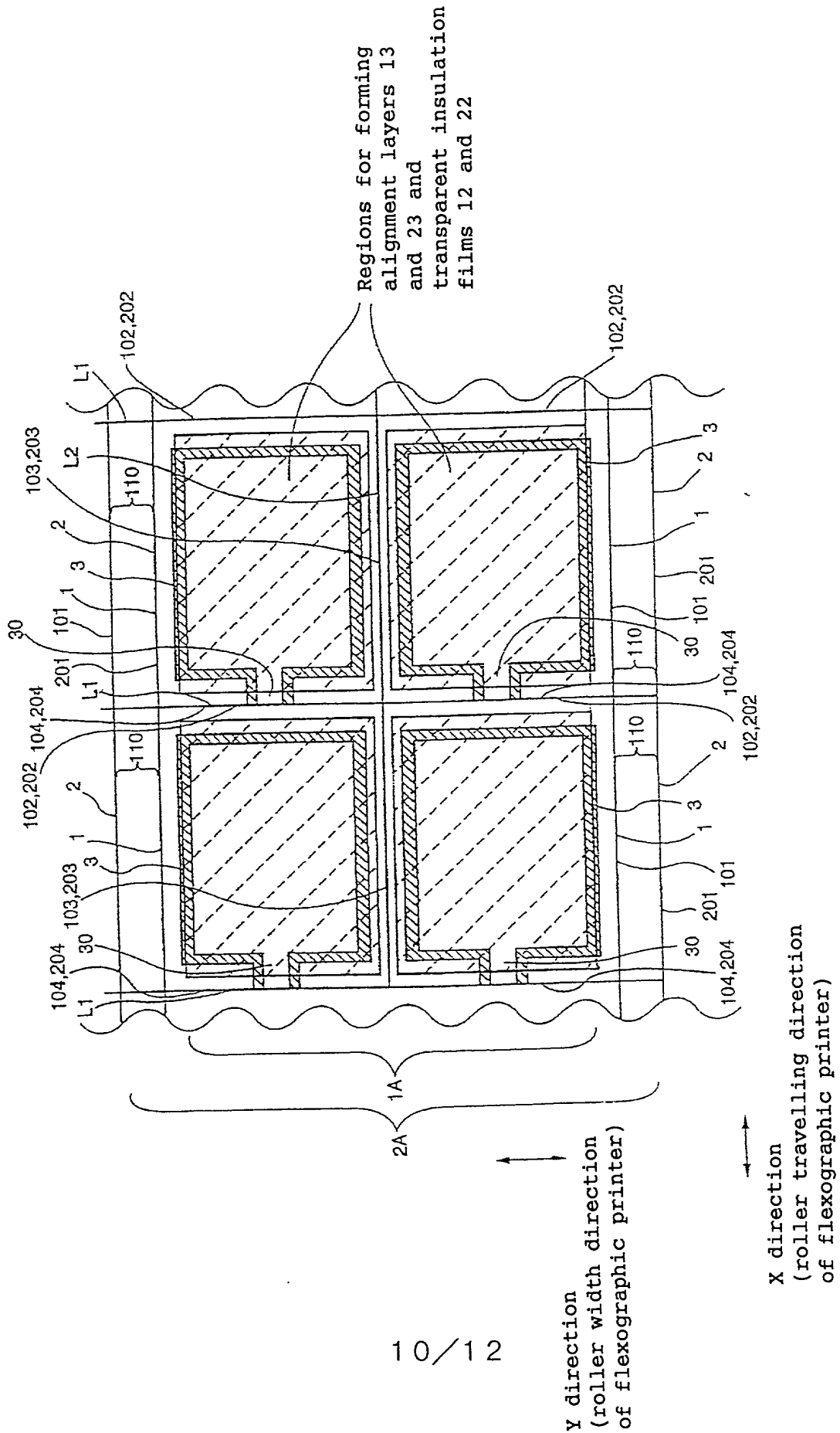


Fig. 11

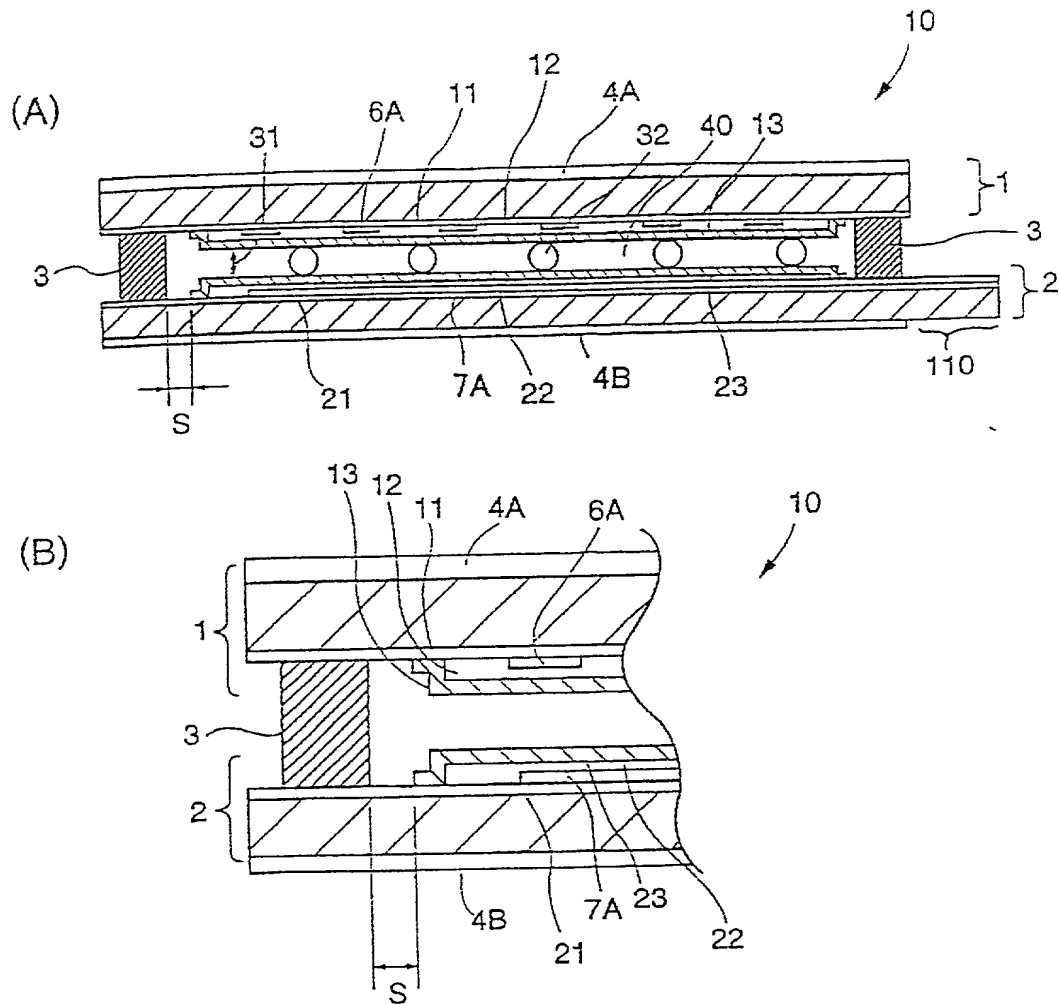
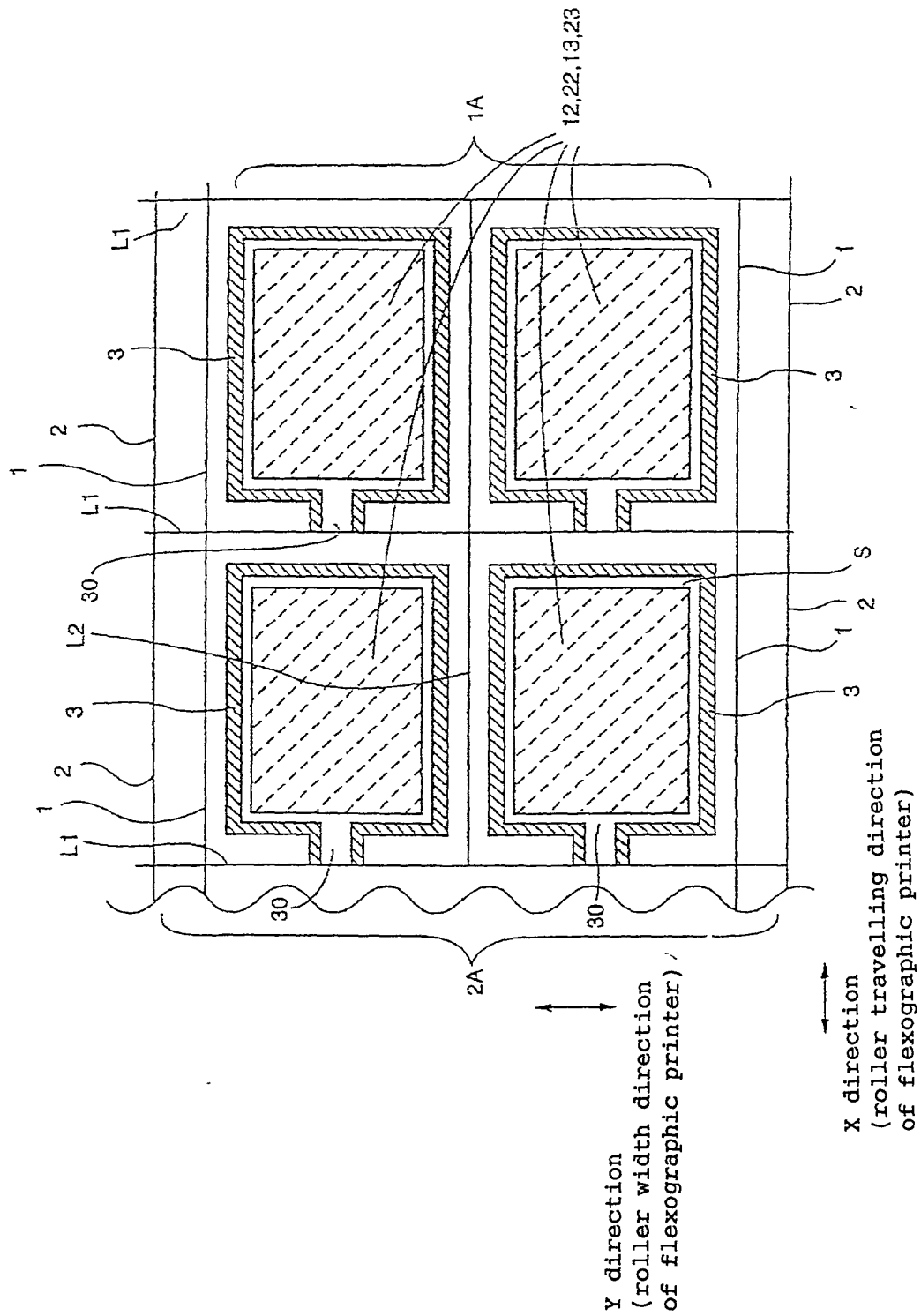


Fig. 12



Seiko Epson Ref. No.: F004329US00

Attorney's Ref. No.: 9319S-000126

Declaration and Power of Attorney For Patent Application

特許出願宣言書及び委任状

Japanese Language Declaration

日本語宣言書

下記の氏名の発明者として、私は以下の通り宣言します。

As a below named inventor, I hereby declare that:

私の住所、私書箱、国籍は、下記の私の氏名の後に記載された通りです。

My residence, post office address and citizenship are as stated next to my name.

下記の名称の発明に関して請求範囲に記載され、特許出願している発明内容について、私が最初かつ唯一の発明者（下記の氏名が一つの場合）もしくは最初かつ共同発明者であると（下記の名称が複数の場合）信じています。

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

液晶パネルおよびその製造方法**LIQUID CRYSTAL PANEL AND METHOD OF FABRICATING THE SAME**

上記発明の明細書（下記の欄で×印がついていない場合は、本書に添付）は、

the specification of which is attached hereto unless the following box is checked:

☒ 1999年8月11日に提出され、米国出願番号または特許協定条約 国際出願番号を PCT/JP99/04364 とし、（該当する場合） _____ に訂正されました。☒ was filed on August 11, 1999 as United States Application Number or PCT International Application Number PCT/JP99/04364 and was amended on _____ (if applicable).

私は、特許請求範囲を含む上記訂正後の明細書を検討し、内容を理解していることをここに表明します。

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

私は、連邦規則法典第37編第1条56項に定義されるとおり、特許資格の有無について重要な情報を開示する義務があることを認めます。

I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, Section 1.56.

Japanese Language Declaration

(日本語宣言書)

私は、米国法典第35編119条(a)-(d)項又は365条(b)項に基づき下記の、米国以外の国の少なくとも1ヶ国を指定している特許協力条約365条(a)項に基づく国際出願、又は外国での特許出願もしくは発明者証の出願についての外国優先権をここに主張するとともに、優先権を主張している、本出願の前に出願された特許または発明者証の外国出願を以下に、枠内をマークすることで、示しています。

I hereby claim foreign priority under Title 35, United States Code, Section 119 (a)-(d) or 365(b) of any foreign application(s) for patent or inventor's certificate, or 365(a) of any PCT International application which designated at least one country other than the United States, listed below and have also identified below, by checking the box, any foreign application for patent or inventor's certificate, or PCT International application having a filing date before that of the application on which priority is claimed.

Prior Foreign Application(s)

外国での先行出願

Priority Not Claimed

優先権主張なし

10-246032(P)

(Number)

(番号)

JAPAN

(Country)

(国名)

31/August/1998

(Day/Month/Year Filed)

(出願年月日)

☐

(Number)

(番号)

(Country)

(国名)

(Day/Month/Year Filed)

(出願年月日)

☐

私は、第35編米国法典119条(e)項に基いて下記の米国特許出願規定に記載された権利をここに主張いたします。

I hereby claim the benefit under Title 35, United States Code, Section 119 (e) of any United States provisional application(s) listed below.

(Application No.)

(出願番号)

(Filing Date)

(出願日)

(Application No.)

(出願番号)

(Filing Date)

(出願日)

私は下記の米国法典第35編120条に基いて下記の米国特許出願に記載された権利、又は米国を指定している特許協力条約365条(c)に基づく権利をここに主張します。また、本出願の各請求範囲の内容が米国法典第35編112条第1項又は特許協力条約で規定された方法で先行する米国特許出願に開示されていない限り、その先行米国出願書提出日以降で本出願書の日本国内または特許協力条約国際提出日までの期間中に入手された、連邦規則法典第37編1章56項で定義された特許資格の有無に関する重要な情報について開示義務があることを認識しています。

I hereby claim the benefit under Title 35, United States Code, Section 120 of any United States application(s), or 365 (c) of any PCT International application designating the United States, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT International application in the manner provided by the first paragraph of Title 35, United States Code, Section 112, I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, Section 1.56 which became available between the filing date of the prior application and the national or PCT International filing date of application:

PCT/JP99/04364

(Application No.)

(出願番号)

11/August/1999

(Filing Date)

(出願日)

Pending

(Status: Patented, Pending, Abandoned)

(現況: 特許許可済、係属中、放棄済)

(Application No.)

(出願番号)

(Filing Date)

(出願日)

(Status: Patented, Pending, Abandoned)

(現況: 特許許可済、係属中、放棄済)

私は、私自身の知識に基づいて本宣言書中で私が行なう表明が真実であり、かつ私が入手した情報と私の信じるところに基づく表明が全て真実であると信じていること、さらに故意になされた虚偽の表明及びそれと同等の行為は米国法典第18編第1001条に基づき、罰金または拘禁、もしくはその両方により処罰されること、そしてそのような故意による虚偽の声明を行えば、出願した、又は既に許可された特許の有効性が失われることを認識し、よってここに上記のごとく宣誓を致します。

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Japanese Language Declaration

(日本語宣言書)

委任状： 私は、下記の発明者として、本出願に関する一切の手続きを米特許商標局に対して遂行する弁理士または代理人として、下記の者を指名いたします。(弁護士、または代理人の氏名及び登録番号を明記のこと)

G. Gregory Schivley, (Reg. 27,382)

Bryant Wade, (Reg. 40,344)

POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith. (list name and registration number)

G. Gregory Schivley, (Reg. 27,382)Bryant Wade, (Reg. 40,344)

書類送付先:

Harness, Dickey & Pierce, P.L.C.

P.O. Box 828

Blomfield Hills, Michigan 48303

Send Correspondence to:

Harness, Dickey & Pierce, P.L.C.

P.O. Box 828

Blomfield Hills, Michigan 48303

直接電話連絡先: (名前及び電話番号)

Harness, Dickey & Pierce, P.L.C.

(248) 641-1600

Direct Telephone Calls to: (name and telephone number)

Harness, Dickey & Pierce, P.L.C.

(248) 641-1600

唯一または第一発明者名

中原 弘 樹

Full name of sole or first inventor

Hiroki NAKAHARA

発明者の署名

日付

中原 弘 樹

2000年3月21日

Inventor's signature

Date

Hiroki Nakahara

March 21, 2000

住所

日本国

長野県

塩尻市

Residence

Shiojiri-shi

Nagano-ken, Japan

JP

国籍

日本

Citizenship

Japan

私書箱

392-8502 日本国長野県諏訪市大和3丁目3番5号
セイコーエプソン株式会社内

Post Office Address

c/o Seiko Epson Corporation

3-5, Owa 3-chome, Suwa-shi, Nagano-ken 392-8502 Japan

第二共同発明者

上 原 秀 樹

Full name of second joint inventor, if any

Hideki UEHARA

第二共同発明者の署名

日付

上 原 秀 樹

2000年3月23日

Second inventor's signature

Date

Hideki Uehara

March 23, 2000

住所

日本国

長野県

茅野市

Residence

Chino-shi

Nagano-ken, Japan

JP

国籍

日本

Citizenship

Japan

私書箱

392-8502 日本国長野県諏訪市大和3丁目3番5号
セイコーエプソン株式会社内

Post Office Address

c/o Seiko Epson Corporation

3-5, Owa 3-chome, Suwa-shi, Nagano-ken 392-8502 Japan

(第三以降の共同発明者についても同様に記載し、署名をすること)

(Supply similar information and signature for third and subsequent joint inventors.)

Under the Paperwork Reduction Act of 1995, no persons are required to respond to collection of information unless it displays a valid OMB control number

Japanese Language Declaration

(日本語宣言書)

委任状： 私は、下記の発明者として、本出願に関する一切の手続きを米特許商標局に対して遂行する弁理士または代理人として、下記の者を指名いたします。(弁護士、または代理人の氏名及び登録番号を明記のこと)

G. Gregory Schivley, (Reg. 27,382)

Bryant Wade, (Reg. 40,344)

POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith. (list name and registration number)

G. Gregory Schivley, (Reg. 27,382)

Bryant Wade, (Reg. 40,344)

書類送付先:

Harness, Dickey & Pierce, P.L.C.

P.O. Box 828

Bloomfield Hills, Michigan 48303

Send Correspondence to:

Harness, Dickey & Pierce, P.L.C.

P.O. Box 828

Bloomfield Hills, Michigan 48303

直接電話連絡先: (名前及び電話番号)

Harness, Dickey & Pierce, P.L.C.

(248) 641-1600

Direct Telephone Calls to: (name and telephone number)

Harness, Dickey & Pierce, P.L.C.

(248) 641-1600

第三共同発明者

宮崎 貴史

Full name of third joint inventor, if any

Takashi MIYAZAKI

第三共同発明者の署名

日付

宮崎 貴史

2000年3月23日

Third inventor's signature

Date

Takashi Miyazaki

March 23, 2000

住所

日本国, 長野県, 松本市

Residence

Matsumoto-shi, Nagano-ken, Japan JP

国籍

日本

Citizenship

Japan

私書箱

392-8502 日本国長野県諏訪市大和3丁目3番5号

セイコーエプソン株式会社内

Post Office Address

c/o Seiko Epson Corporation

3-5, Owa 3-chome, Suwa-shi, Nagano-ken 392-8502 Japan

第四共同発明者

萩原 武

Full name of fourth joint inventor, if any

Takeshi HAGIWARA

第四共同発明者の署名

日付

萩原 武

2000年3月23日

Fourth inventor's signature

Date

Takeshi Hagiwara

March 23, 2000

住所

日本国, 長野県, 松本市

Residence

Matsumoto-shi, Nagano-ken, Japan JP

国籍

日本

Citizenship

Japan

私書箱

392-8502 日本国長野県諏訪市大和3丁目3番5号

セイコーエプソン株式会社内

Post Office Address

c/o Seiko Epson Corporation

3-5, Owa 3-chome, Suwa-shi, Nagano-ken 392-8502 Japan

(第五以降の共同発明者についても同様に記載し、署名をすること)

(Supply similar information and signature for fifth and subsequent joint inventors.)